



US006286554B1

(12) **United States Patent**
Staley

(10) **Patent No.:** **US 6,286,554 B1**
(45) **Date of Patent:** ***Sep. 11, 2001**

(54) **APPARATUS AND METHOD TO SHIELD AND OPEN A TUBE**

(75) Inventor: **Dennis Staley**, Boise, ID (US)

(73) Assignee: **Micron Technology, Inc.**, Boise, ID (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/350,638**

(22) Filed: **Jul. 9, 1999**

Related U.S. Application Data

(62) Division of application No. 09/032,701, filed on Mar. 2, 1998, now Pat. No. 6,004,401.

(51) **Int. Cl.**⁷ **B65D 59/00**; E03B 11/00

(52) **U.S. Cl.** **138/96 R**; 138/89; 134/902; 137/590

(58) **Field of Search** 138/96 R, 96 T, 138/89; 134/902, 186; 137/590.5, 590

(56) **References Cited**

U.S. PATENT DOCUMENTS

548,215	10/1895	Montgomery et al.	137/590.5
622,376	* 4/1899	Lieber	138/96 R
833,150	10/1906	Attenhofer	137/590.5
1,135,900	4/1915	Hughson	137/590 X
1,139,129	5/1915	Lyons	137/590 X
1,575,586	3/1926	Klattenburg et al.	137/590 X
1,956,524	4/1934	Byram	137/590.5
2,541,095	2/1951	Pilkey	137/590
2,705,503	4/1955	Price	137/590

2,780,718	*	2/1957	Mullen	138/96 R X
3,756,314	*	9/1973	Valley	138/96 R X
3,757,826	*	9/1973	Kroll	138/96 R X
3,870,067		3/1975	Janiszewski	137/590 X
3,874,402		4/1975	Hazen	137/590 X
4,092,746		6/1978	Harris	137/590.5
4,202,378	*	5/1980	Bush et al.	138/96 R
5,520,219	*	5/1996	Hessian	138/96 R X
5,613,615	*	3/1997	Zeyfang et al. .	
5,816,274		10/1998	Bartram et al.	134/902
5,845,663		12/1998	Han	134/902
5,873,381		2/1999	Han	134/18.2
5,921,267		7/1999	Lin	137/590.5 X

FOREIGN PATENT DOCUMENTS

485622	*	8/1952	(CA)	138/96 R
715160	*	8/1965	(CA)	138/96 R
1285600	*	3/1961	(FR)	138/96 R
1093267	*	11/1967	(GB)	138/96 R

* cited by examiner

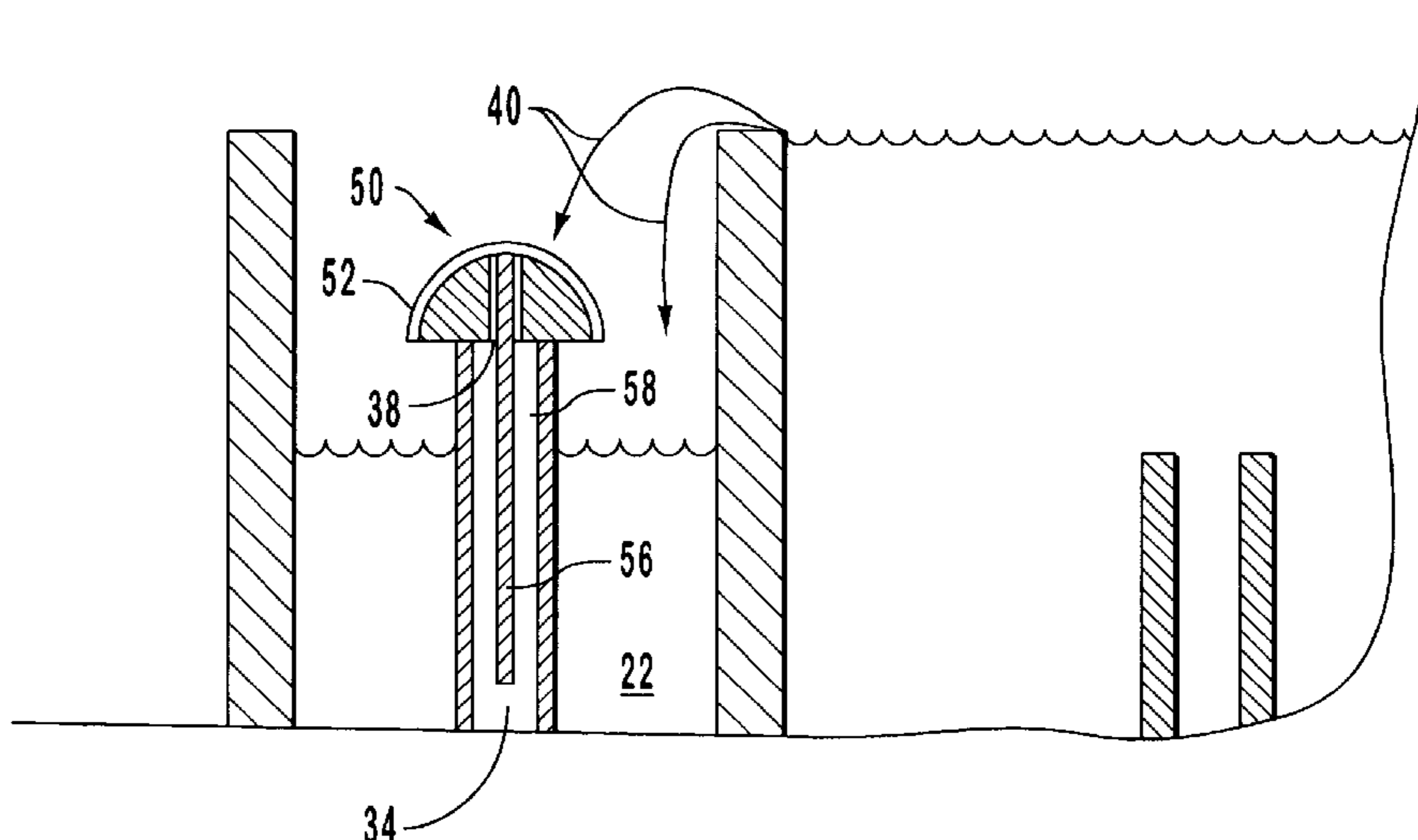
Primary Examiner—Patrick Brinson

(74) *Attorney, Agent, or Firm*—Workman, Nydegger & Seeley

(57) **ABSTRACT**

A shielding apparatus for preventing premature entry of a liquid into an overflow drain tube. The shielding apparatus has a shielding member, which may be convex, positioned over an opening of the overflow drain tube. The shielding member deflects airborne liquid and prevents the airborne liquid from passing through the opening. The shielding apparatus also has at least one stem that is inserted through the opening and into the bore of the overflow drain tube. At least one spacer provides a space between at least a portion of the shielding member and a rim that surrounds the opening. The shielding apparatus may be used in a system for cleaning semiconductor structures by preventing liquid from being splashed or projected into the opening of the overflow drain tube. Methods for shielding an overflow drain tube and for cleaning semiconductor structures are also disclosed.

32 Claims, 5 Drawing Sheets



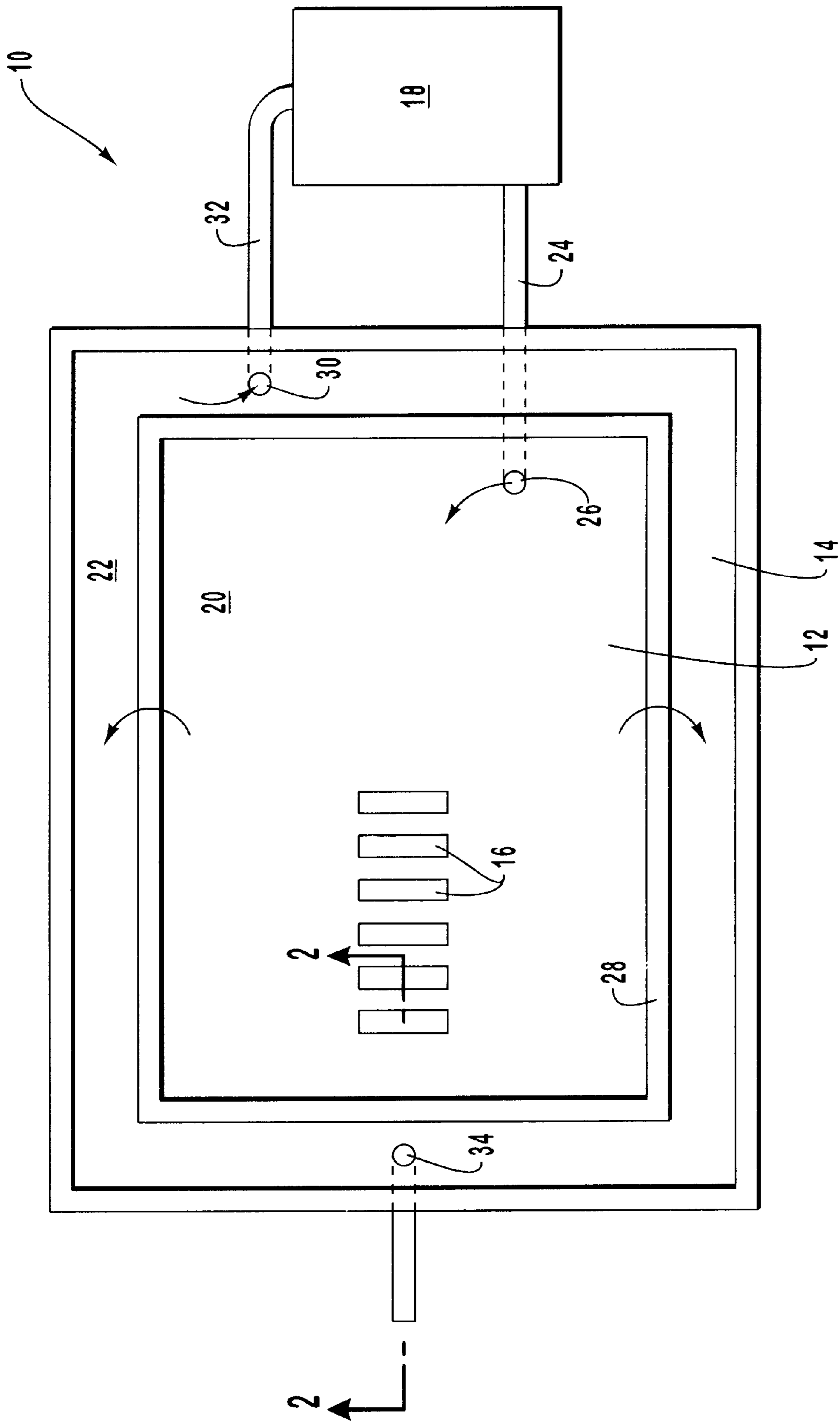


FIG. 1

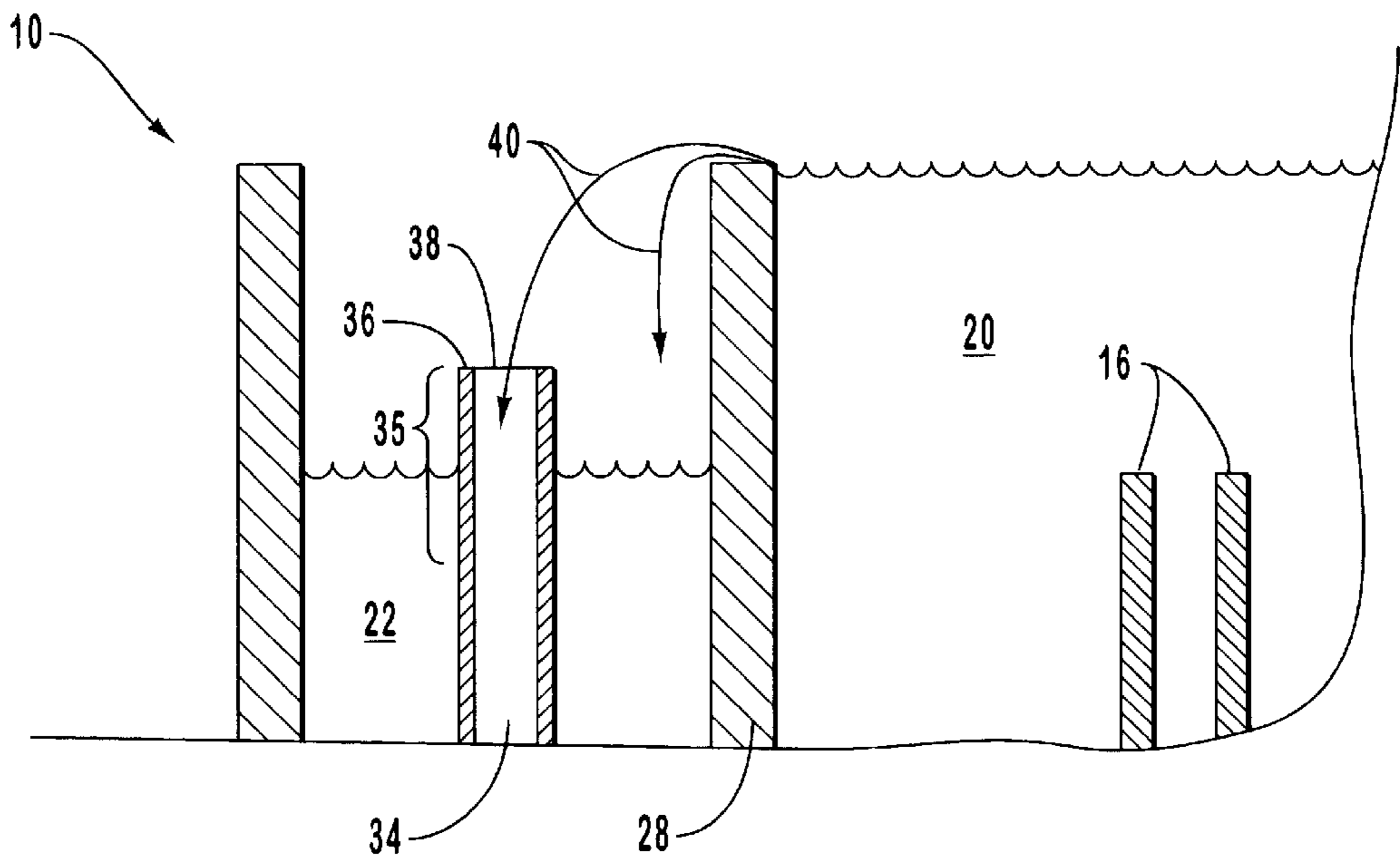


FIG. 2

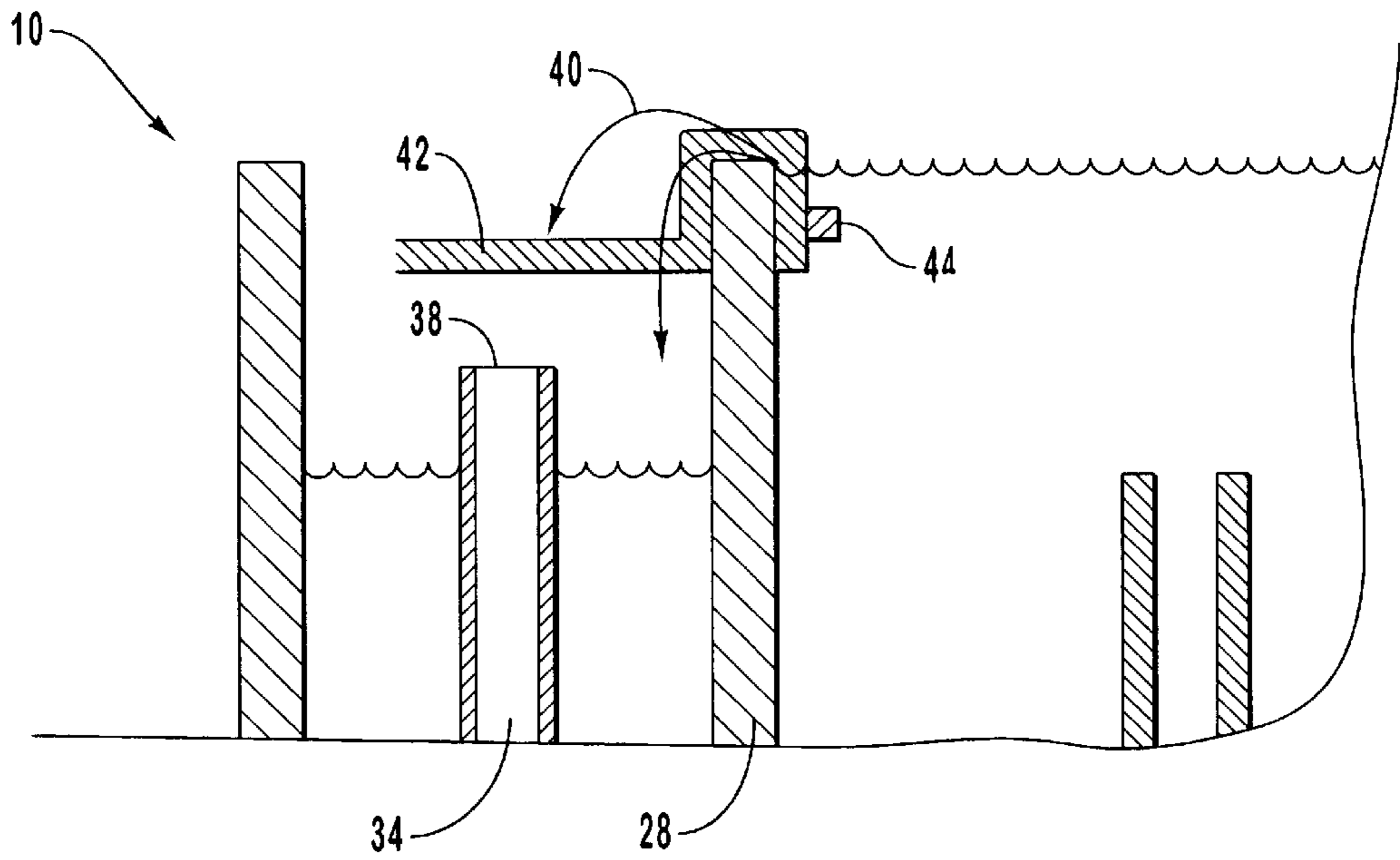


FIG. 3
(PRIOR ART)

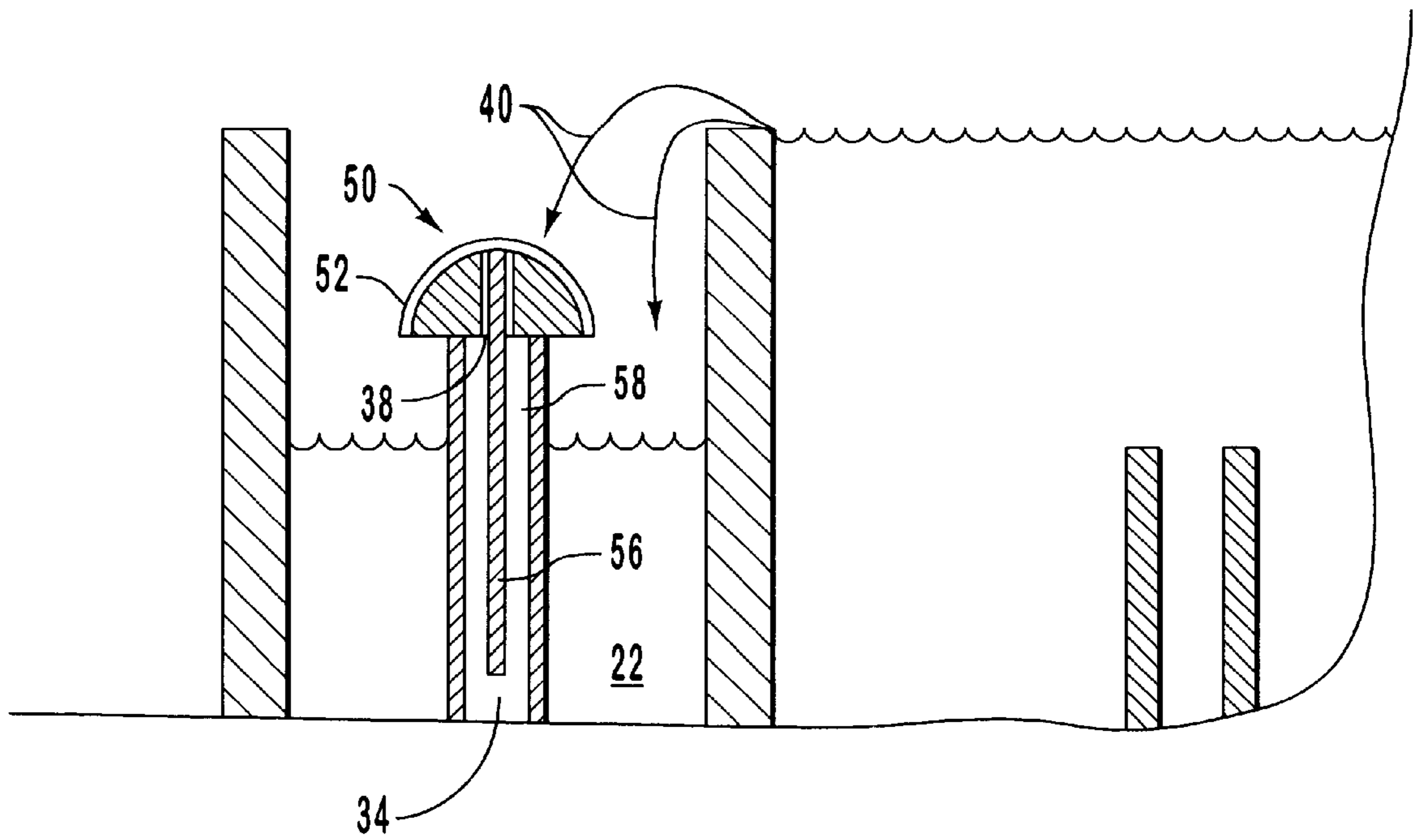


FIG. 4

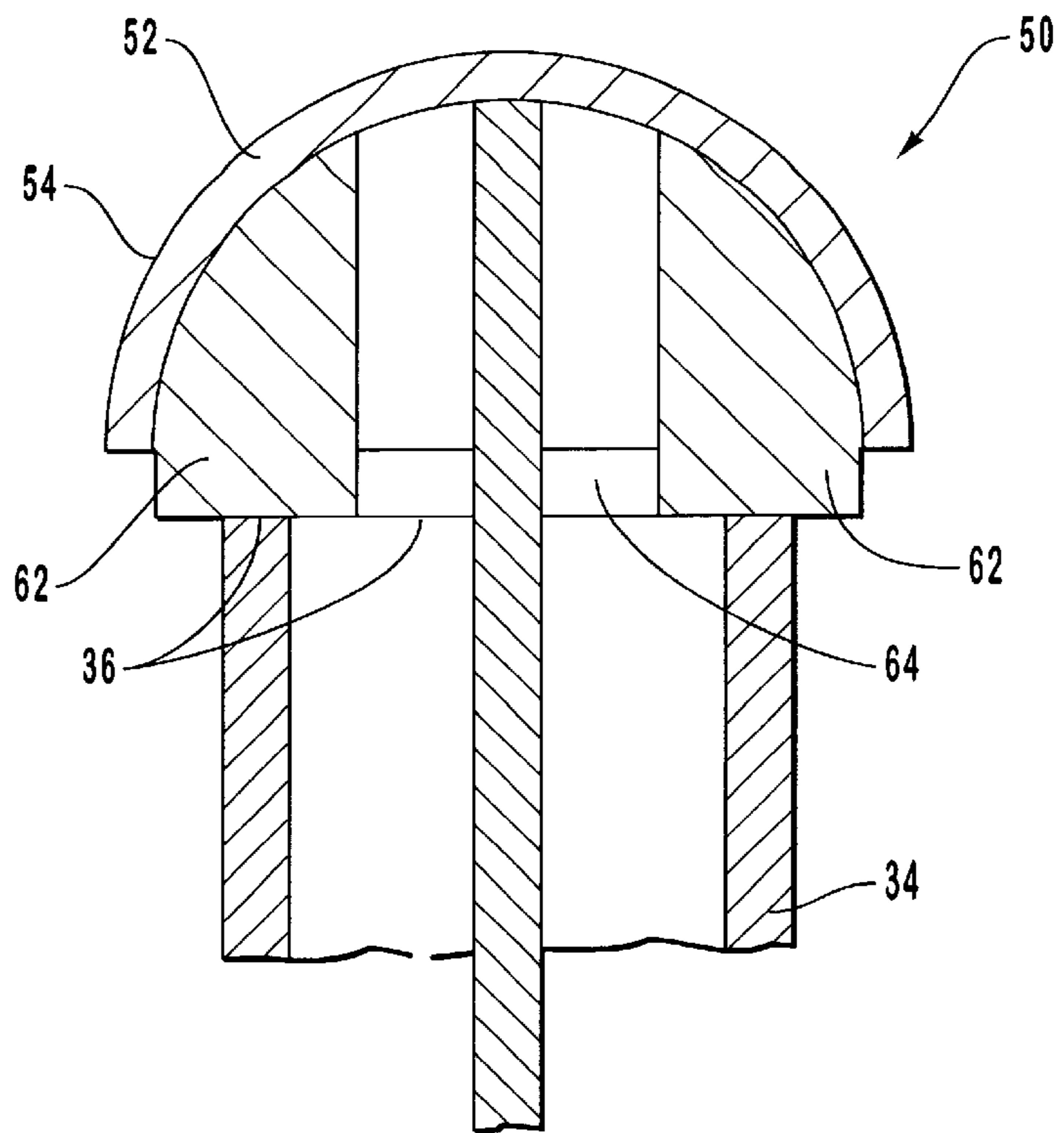


FIG. 5

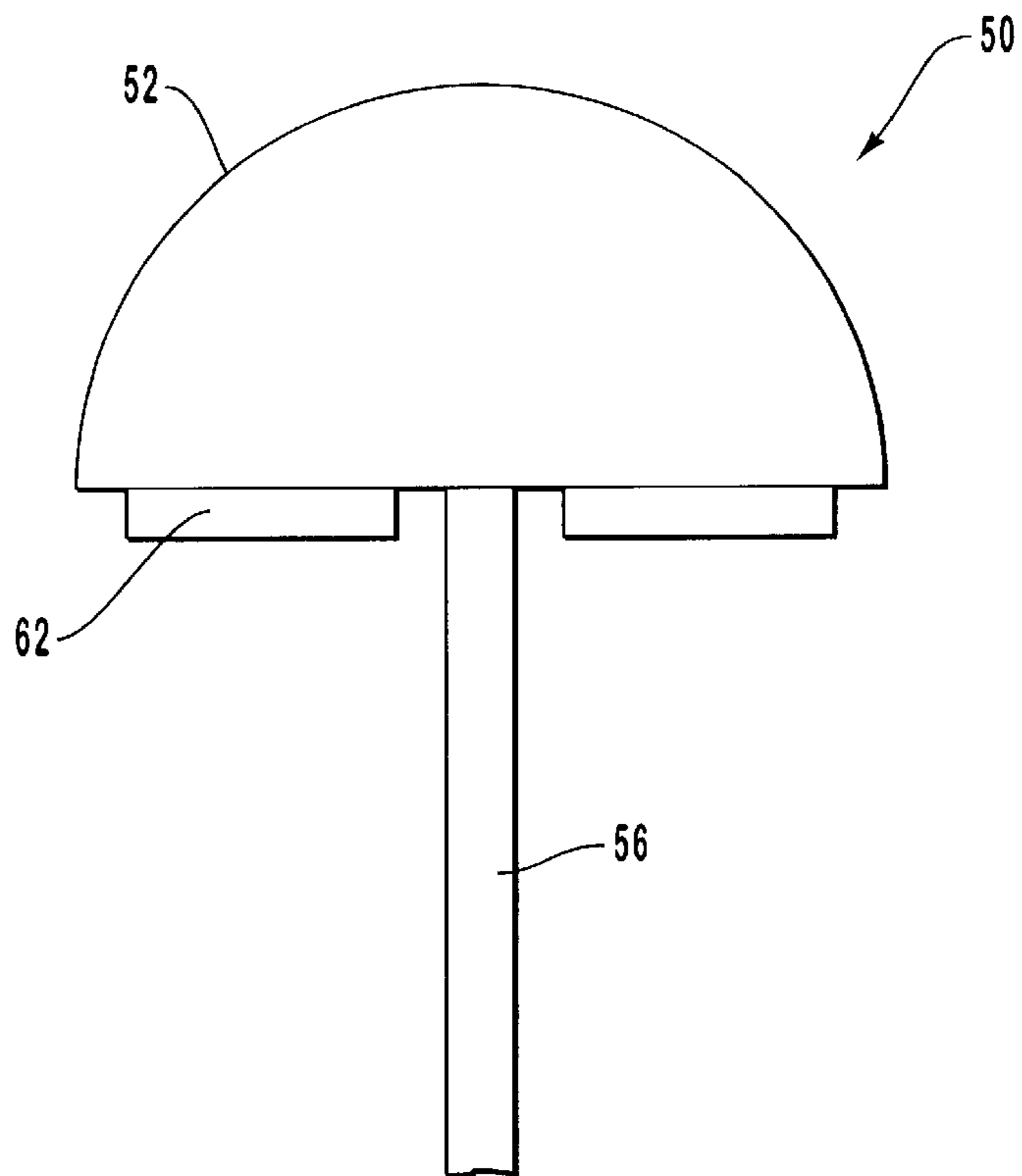


FIG. 6

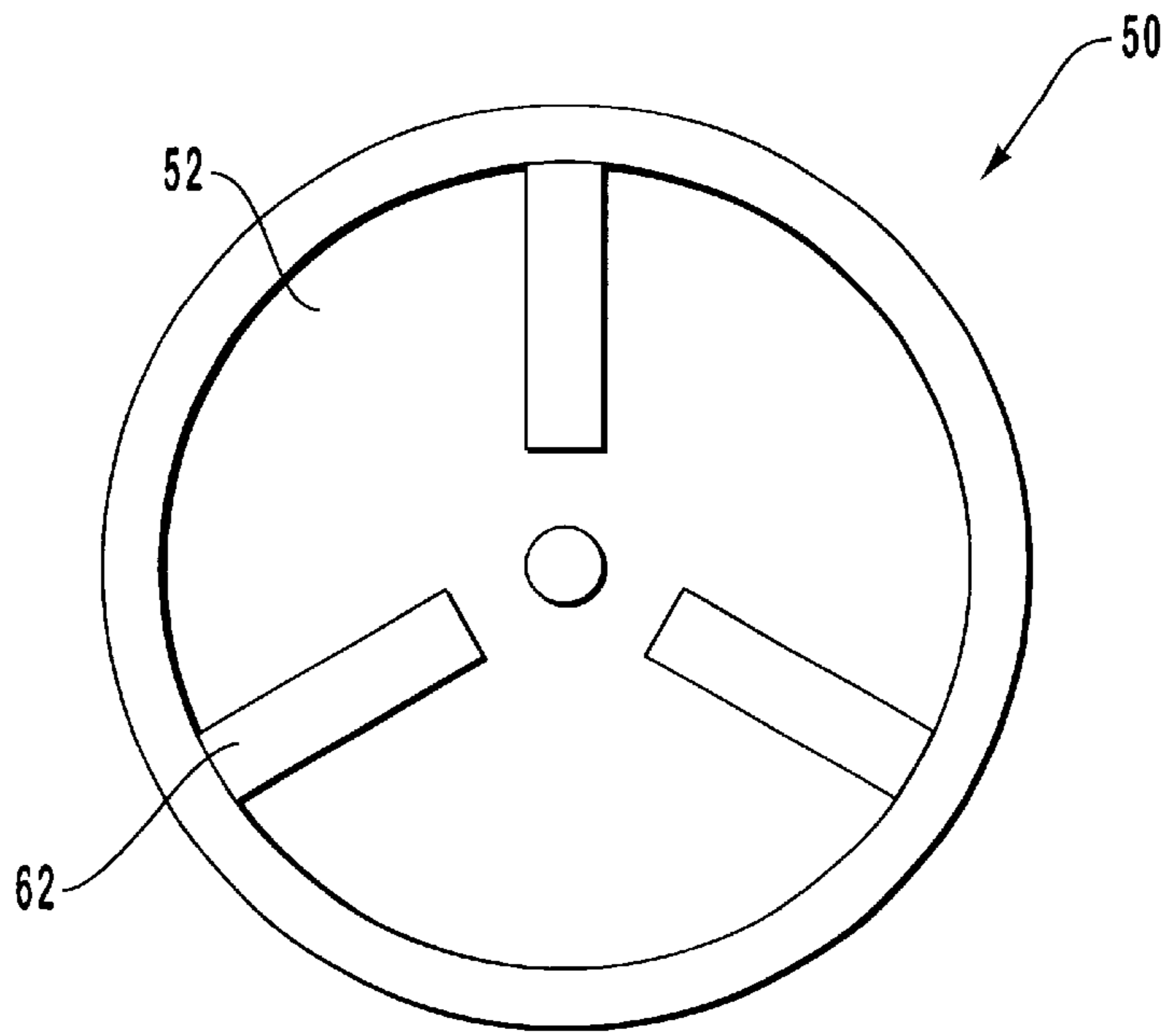


FIG. 7

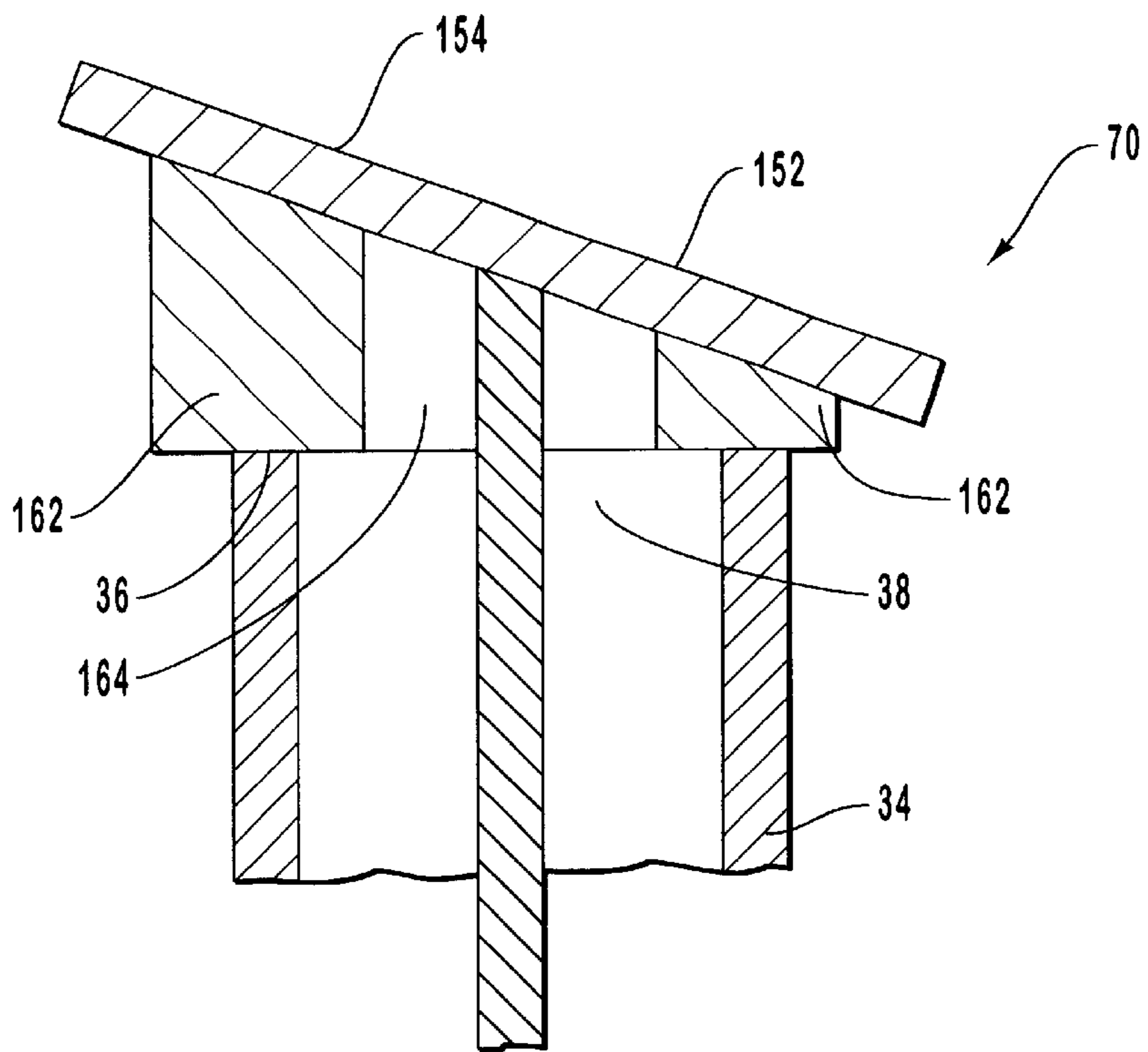


FIG. 8

APPARATUS AND METHOD TO SHIELD AND OPEN A TUBE

This application is a divisional application of U.S. patent application Ser. No. 09/032,701, filed on Mar. 2, 1998 now U.S. Pat. No. 6,004,401, which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. The Field of the Invention

The present invention relates to systems and methods for regulating the flow of a liquid through tanks or reservoirs. More particularly, the present invention relates to a shielding apparatus for preventing the premature flow of a liquid through an overflow drain tube. The shielding apparatus may be used in systems for cleaning semiconductor structures in an acid bath.

2. The Relevant Technology

Integrated circuits and other semiconductor structures are currently manufactured by an elaborate process in which semiconductor devices, insulating films, and patterned conducting films are sequentially constructed in a predetermined arrangement on a semiconductor substrate. In the context of this document, the term "semiconductor substrate" is defined to mean any construction comprising semiconductive material, including but not limited to bulk semiconductive material such as a semiconductive wafer, either alone or in assemblies comprising other materials thereon, and semiconductive material layers, either alone or in assemblies comprising other materials. The term "substrate" refers to any supporting structure including but not limited to the semiconductor substrates described above. The term "semiconductor structure" shall refer to any construction that includes semiconductive material or that is formed over a semiconductor substrate. The term semiconductor substrate is contemplated to include such structures as silicon-on-insulator and silicon-on-sapphire.

During the process of manufacturing integrated circuits and other semiconductor structures, contaminants, such as particulates and residue, accumulate on surfaces thereof. These contaminants generally must be cleaned from surfaces of semiconductor structures in order to ensure reliable operation of the finished product and to allow formation of further layers and structures on the surfaces. A common method of cleaning semiconductor structures involves an acid bath in which the semiconductor structures are placed in a tank or reservoir containing an acidic solution.

A conventional system for cleaning semiconductor structures is seen in FIG. 1. Cleaning system 10 includes an inner first reservoir 12 and an outer second reservoir 14. A plurality of semiconductor wafers 16 are placed within first reservoir 12, and are commonly secured in position using a boat or another carrier. Cleaning system 10 is operated by circulating a liquid through the reservoirs 12 and 14 using pump 18. The liquid may be, for example, an acidic solution including sulfuric acid.

A first volume 20 of the liquid is contained in first reservoir 12 and a second volume 22 of the liquid is contained in second reservoir 14. Pump 18 causes the liquid to flow through an inlet channel 24 and through an inlet orifice 26 into first reservoir 12. The acidic solution flows over the surfaces of semiconductor wafers 16 in first reservoir 12, thereby dissolving, chemically degrading, or otherwise washing away contaminants and impurities. The liquid leaves first reservoir 12 by flowing or cascading over inner wall 28 and into second reservoir 14. The liquid is held

in second reservoir 14 until it is pumped into outlet orifice 30 and through outlet channel 32 into pump 18. During operation of cleaning system 10, the flow of liquid through pump 18 and the elevations of first volume 20 and second volume 22 remain substantially constant.

Occasionally, outlet channel 32 is blocked, or the normal flow of liquid through cleaning system 10 is otherwise disrupted. In order to deal with such situations, a safety mechanism, including overflow drain tube 34, is included in cleaning system 10 to prevent the acidic solution from overflowing into the surrounding environment. This is particularly important because spillage of the acidic solution would be hazardous to nearby technicians, other workers, and laboratory and industrial property.

As seen in FIG. 2, overflow drain tube 34 typically extends through second volume 22 and has a substantially vertical axis through a section 35 that terminates at rim 36 surrounding opening 38. Opening 38 is positioned at a predetermined elevation over the normal operating elevation of second volume 22. Under ordinary conditions, second volume 22 has an equilibrium elevation that is several inches lower than the elevation of first volume 20. When cleaning system 10 malfunctions and second volume 22 rises to an elevation equal to or slightly higher than the predetermined elevation, some of the liquid pours over rim 36 and is removed from cleaning system 10 through overflow drain tube 34.

While the foregoing system for draining excess liquid and preventing overflow is generally adequate for preventing acid from spilling into the surroundings, a problem has been observed during operation of the system. This problem arises when a portion of the liquid becomes airborne in cleaning system 10. For example, as liquid moves from first volume 20 to second volume 22, some of the liquid is splashed or otherwise projected into the air above second volume 22 at some point during operation of cleaning system 10. Alternatively, when the liquid in cleaning system 10 is heated, the liquid can be head to a rolling boil which may cause the liquid to splash or otherwise be projected into the air above second volume 22. Airborne liquid 40, from either of the two foregoing scenarios, can fall through opening 38 and be prematurely drained from the cleaning system 10 through overflow drain tube 34.

It has been found that during extended operation of cleaning system 10, enough of the liquid becomes airborne and passes through opening 38 to significantly lower the elevation of second volume 22. Eventually, second volume 22 may be left with little or no liquid such that pump 18 begins to draw air through outlet channel 32. In such situations, the entire system is disrupted, often to the extent that semiconductor wafers 16 are dislodged from their position within first reservoir 12. Accordingly, semiconductor wafers 16 may be damaged or, in any event, the system must be shut down for a period of time which leads to inefficiency and increases the cost of the manufacturing process.

FIG. 3 illustrates a cantilevered shielding apparatus 42 that has been developed in response to the foregoing problem of premature drainage of liquid through overflow drain tube 34. Cantilevered shielding apparatus 42 covers opening 38 to prevent airborne liquid 40 from passing therethrough. Cantilevered shielding apparatus 42 is supported by inner wall 28 and is secured thereto by means of a screw 44 or other tightening device. However, cantilevered shielding apparatus 42 has often proved unsatisfactory because it is easily dislodged from inner wall 28. When cantilevered

shielding apparatus **42** is displaced or falls out of position, it loses its effectiveness, and airborne liquid **40** begins to be projected into opening **38** once again. In such circumstances, cleaning system **10** is easily disrupted as if no shielding apparatus were present, and semiconductor wafers **16** are again at risk of being damaged.

In view of the foregoing, it would be an advancement in the art to provide a shielding apparatus that prevents entry of airborne liquid into an overflow drain tube while reliably remaining in position relative to the drain tube. It would also be an advancement in the art to provide systems and methods for cleaning semiconductor structures using such a reliable shielding apparatus.

SUMMARY OF THE INVENTION

The present invention is directed to an apparatus for shielding an opening of a tube and for preventing airborne liquid from falling into the opening. According to the invention, a tube has a rim at one end thereof. The rim defines both a plane and an opening to the tube. A shielding member is provided over the opening of the tube and has a width greater than that of the opening. A structure, which can be one or more spacers, is in contact with the shielding member. The structure is also in contact with the rim. The interface between the structure and the rim is substantially co-planar with the plane defined by the rim. The structure provides a gap that is in fluid communication with the opening.

The shielding member is a part of a shielding apparatus and has a generally convex top surface configured to deflect any airborne liquid that comes in contact therewith. At least one stem extends from the shielding member such that the stem may be inserted into the bore of the tube. The stem serves to align the shielding member with the opening of the tube and to secure the shielding apparatus in place.

Alternatively stated, the shielding apparatus has one or more structures, such as spacers, that are configured to be in contact with the rim of the tube. The spacers provide a space between at least a portion of the shielding member and the rim. This space allows liquid to flow over the rim and into the opening if a volume of liquid reaches a predetermined elevation. In this manner, the tube can function as an overflow drain tube while the shielding apparatus is in position.

The shielding apparatus of the invention is not merely fastened to a wall of a tank or reservoir with which it is used, but is instead in contact with the tube that is to be shielded. The shielding apparatus as disclosed herein is not subject to being dislodged or displaced during operation of a cleaning system in which it is used. As a result, a cleaning system using the shielding apparatus may be reliably operated for an extended period without the risk of the liquid of the system being prematurely drained through the overflow drain tube.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the manner in which the above-recited and other advantages and objects of the invention are obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope, the invention will be described with additional specificity and detail through the use of the accompanying drawings in which:

FIG. 1 is a top view of a prior art system for circulating a cleaning solution through a series of reservoirs and over a plurality of semiconductor structures.

FIG. 2 is a partial cross sectional elevation view of the system of FIG. 1 taken along section line 2—2, illustrating an overflow drain tube positioned within an outer reservoir to receive excess liquid.

FIG. 3 is a partial cross sectional elevation view of the system of FIG. 1 taken along section line 2—2, and adding thereto an depiction of a cantilevered shielding apparatus as practiced in the prior art.

FIG. 4 is a partial cross sectional elevation view of the system of FIG. 1 taken along section line 2—2, and adding thereto an depiction of a shielding apparatus of the present invention. The shielding apparatus is positioned in contact with an overflow drain tube of cleaning system.

FIG. 5 is a partial cross section elevation view of the shielding apparatus of FIG. 4 installed in a overflow drain tube.

FIG. 6 is a partial elevation view of the shielding apparatus of FIG. 4.

FIG. 7 is a bottom view of the shielding apparatus of FIG. 4.

FIG. 8 is a partial cross section elevation view of the system of FIG. 1 taken along section line 2—2, and adding thereto an depiction of another embodiment of a shielding apparatus according to the invention, in which the shielding apparatus has a substantially planar shielding member.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is directed to a shielding apparatus for preventing liquid from prematurely passing into an opening of a tube. The shielding apparatus is configured to be placed in contact with the tube that is to be shielded. The shielding apparatus includes a shielding member which is disposed over the opening of the tube in order to deflect airborne liquid away from the opening. As used herein, the term "airborne liquid" shall refer to a liquid or a portion of a liquid that is cast, projected, or splashed into the air; that is cascading or falling from a higher level to a lower level; or that is in a state of free fall. The shielding member may be convex or may have another suitable shape that directs liquid away from the opening. At least one stem extends from the shielding member and is inserted into a bore of the tube in order to align the shielding member with the opening and to prevent the shielding apparatus from being displaced. A spacer provides a space between a rim that surrounds the opening of the tube and at least a portion of the shielding member. Accordingly, the opening remains unobstructed and can drain excess liquid from a tank or reservoir while the shielding apparatus is in position.

FIG. 4 illustrates a shielding apparatus **50** of the invention removably positioned in contact with an overflow drain tube **34** of the cleaning system of FIGS. 1 and 2. Shielding apparatus **50** includes a shielding member **52** that is configured to be positioned over opening **38**. Shielding member **52** is but one example of shielding means for substantially preventing airborne liquid **40** from entering into opening **38**. Shielding member **52** preferably has a convex top surface **54**. Alternatively, top surface **54** may have any other shape or configuration that is suitable for intercepting and diverting substantially all of airborne liquid **40** that would otherwise pass through opening **38**. For example, top surface may instead be substantially planar and angularly displaced from the horizontal plane. Such a planar surface also shields opening **38** and directs airborne liquid **40** away from opening **38**.

Shielding apparatus **50** also includes aligning means for maintaining alignment between shielding member **52** and

opening 38. A preferred example of such aligning means is stem 56 that extends from shielding member 52 and is inserted into bore 58 of overflow drain tube 34. Stem 56 aligns shielding member 52 with opening 38 by constraining the distance that shielding member 52 may laterally move. If shielding apparatus 50 is moved sideways over overflow drain tube 34, stem 56 ensures that opening 38 remains covered by shielding member 52. Shielding apparatus 50 may include more than one stem 56. Alternatively, the invention may be practiced with other structures for aligning shielding member 52 with opening 38.

In a preferred embodiment, shielding apparatus 50 consists of a material or materials that have a relative density that is less than the relative density of the liquid in cleaning system 10. Accordingly, in the case that second volume 22 rises to a predetermined elevation at which it drains through overflow drain tube 34, shielding apparatus 50 will float in the liquid and be vertically displaced through some distance. This vertical displacement reduces the obstruction of opening 38 and facilitates draining of excess liquid through overflow drain tube 34. Stem 56 preferably has a sufficient length and extends into bore 58 a sufficient distance such that stem 56 remains in bore 58 in the event that shielding apparatus 50 is caused to float in the liquid.

FIG. 5 is an enlarged cross-sectional view of shielding apparatus 50 and overflow drain tube 34 of FIG. 4. Shielding apparatus 50 preferably includes spacing means for providing a space between shielding member 52 and at least a portion of rim 36. A preferred example of such spacing means is at least one spacer 62 that is configured to be in contact with overflow drain tube 34. In particular, spacers 62 preferably rest upon rim 36 such that at least a portion of shielding member 50 is separated from rim 36. Accordingly, spacers 62 constitute one example of a portion of shielding apparatus 50 that may be in contact with overflow drain tube 34. Spacers 62 provide a space 64 between at least a portion of shielding member 50 and overflow drain tube 34 when stem 56 is fully inserted into bore 58. Space allows overflow drain tube 34 to receive excess liquid while shielding apparatus 50 is disposed upon rim 36. Spacers 62 are not limited to the structure shown in FIG. 5, but may instead be another structure for providing space 64.

Turning now to FIG. 6, shielding apparatus 50 is preferably constructed of a material that is substantially inert to the liquid of the system in which it is used. At least the entire surface of shielding apparatus 50 should consist of such an inert material. As used herein, "entire surface" includes at least all surfaces of shielding member 52, stem 56, and spacers 62 that are exposed and that may come into contact with the liquid during use of shielding apparatus 50 or the system in which it is used. When common acidic solutions are used in the cleaning system, shielding apparatus 50 may be constructed, for example, of tetrafluoroethylene.

FIG. 7 illustrates shielding apparatus 50 as viewed from below. By way of example and not by limitation, it has been found that shielding member 52 may be radially symmetric about an axis that is parallel to stem 56. It is also convenient for shielding member 52 to further have a circular profile when viewed from below, as in FIG. 7. A radially symmetric and circular profile advantageously allows shielding member 52 to correspond to the conventionally circular shape of overflow drain tube 34. It has also been found that a convenient arrangement of spacers 62 is that seen in FIG. 7, wherein three spacers 62 are circumferentially and equally spaced around shielding member 52. Accordingly, shielding apparatus 50 may securely rest upon rim 36 of overflow drain

FIG. 8 depicts an alternative embodiment of a shielding apparatus 70 according to the invention. Shielding apparatus 70 has a shielding member 152 with a substantially planar top surface 154 that is angularly displaced from the horizontal plane. Shielding member 152 may be positioned over opening 38 of overflow drain tube 34 in order to prevent airborne liquid from entering opening 38. Spacers 162 are adapted to rest upon rim 36 to provide a space 164 between rim 36 and a portion of shielding member 152. In other respects, the features, elements, and use of shielding member 70 are substantially the same as those of shielding member 50 of FIGS. 4-7 as disclosed herein.

The shielding apparatus of the present invention may be adapted and used to shield openings of tubes other than the overflow drain tube disclosed herein. Moreover, the invention is not limited to a cleaning system or to the particular cleaning system specified herein. Instead, the shielding apparatus may be advantageously used in combination with substantially any opening to prevent airborne liquid from passing therethrough.

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed and desired to be secured by United States Letters Patent is:

1. An apparatus for preventing loss of liquid, said apparatus comprising:
 - a reservoir for containing liquid;
 - a tube having first and second separated openings in fluid communication with a lumen extending therebetween, wherein:
 - the first opening is in fluid communication with an exit from the reservoir;
 - the second opening has a perimeter;
 - a shielding member that terminates at a perimeter that is larger than and vertically aligned over the perimeter of the second opening to the tube; and
 - a support structure attached to said shielding member such that said shielding member and said support structure can move free relative to said tube and said shielding member maintains vertical alignment with said tube.
2. An apparatus as defined in claim 1, wherein said shielding member is positioned over but does not close said second opening to the tube.
3. An apparatus as defined in claim 1, wherein at least a portion of said shielding member is separated from said second opening to the tube such that a gap is positioned therebetween.
4. An apparatus as defined in claim 1, wherein:
 - the support structure includes a spacer that provides a gap between at least a portion of said shielding member and the second opening of said tube when said spacer is in contact with said perimeter.
5. An apparatus as defined in claim 1, wherein said shielding member is configured to prevent entry of an airborne liquid into said second opening of said tube.
6. An apparatus as defined in claim 1, further comprising at least one stem extending away from said shielding member into the second opening of said tube.
7. An apparatus for shielding an entrance to a tube, said apparatus comprising:

7

- a reservoir for containing liquid;
 a tube secured within the reservoir and having first and second opposite openings in fluid communication with a lumen extending therebetween, wherein the first opening is in fluid communication with an exit from the reservoir and the second opening is defined by a rim that has an upper perimeter;
 a shielding member having a convex top surface;
 at least one stem extending away from said shielding member, said at least one stem being configured to be inserted into said second opening of said tube; and
 at least one spacer for contacting said upper perimeter at discrete portions of said perimeter, such that when said at least one spacer contacts said rim, spaces between said discrete portions are defined between the upper perimeter of said rim and the shielding member, and said spaces allow fluid access to said second opening.
- 8.** An apparatus as defined in claim 7, wherein said shielding member is radially symmetric about an axis that is parallel to said stem.
- 9.** An apparatus as defined in claim 7, wherein said shielding member is composed of tetrafluoroethylene.
- 10.** An apparatus as defined in claim 7, wherein said shielding member is configured to prevent entry of an airborne liquid into said second opening of said tube.
- 11.** An apparatus for shielding an entrance to a tube comprising:
 a reservoir for containing liquid;
 a tube secured within the reservoir and having first and second opposite openings in fluid communication with a lumen extending therebetween, wherein:
 the first opening is in fluid communication with an exit from the reservoir;
 a rim surrounds said second opening, and said rim has an upper perimeter; and
 a shielding apparatus provided with at least one spacer attached thereto for contacting said rim at discrete intervals of said rim, said at least one spacer being attached to said shielding apparatus at discrete portions thereof, and said shielding apparatus including a shielding member having a convex top surface, said shielding member being positioned over said second opening of the tube, such that when said at least one spacer contacts said rim, spaces between said discrete intervals are defined between the upper perimeter of said rim and the shielding member, and said spaces allow fluid access to said second opening.
- 12.** An apparatus as defined in claim 11, wherein said tube is symmetrical about an axis that terminates at said rim.
- 13.** An apparatus as defined in claim 11, wherein a gap is between at least a portion of said shielding member and the rim surrounding said second opening of said tube.
- 14.** An apparatus as defined in claim 13, wherein said shielding apparatus further comprises a spacer in contact with said tube such that said gap is provided.
- 15.** An apparatus as defined in claim 11, wherein said shielding apparatus further comprises at least one stem extending into said tube.
- 16.** An apparatus as defined in claim 11, wherein said shielding apparatus is removably positioned in contact with said tube.
- 17.** An apparatus system for shielding an end of a tube, said apparatus comprising:
 a reservoir for containing liquid;
 a tube secured within the reservoir and having first and second opposite openings in fluid communication with a lumen extending therebetween, wherein:

8

- the first opening is in fluid communication with an exit from the reservoir; and
 a rim surrounds said second opening and said rim has an upper perimeter; and
 a shielding apparatus provided with spacing means attached thereto for contacting said rim at discrete intervals of said rim, said spacing means being attached to said shielding apparatus at discrete portions thereof, and said shielding apparatus including:
 shielding means for substantially preventing an airborne liquid from entering said second opening of said tube without closing said second opening; and
 aligning means for maintaining alignment between said shielding means and said second opening; such that when said spacing means contacts said rim, spaces between said discrete intervals are defined between the upper perimeter of said rim and the shielding member, and said spaces allow fluid access to said second opening.
- 18.** A method for shielding an entrance to a tube from a liquid, said method comprising:
 providing a tube having first and second separated openings in fluid communication with a lumen extending therebetween, wherein the first opening is in fluid communication with an exit from a reservoir for containing a fluid, and the second opening is surrounded by a rim that has an upper perimeter; and
 positioning a shielding apparatus to rest upon the second opening of said tube, said shielding apparatus including a material causing buoyancy of the shielding apparatus when immersed in said liquid, and
 a spacer for contacting said rim at discrete intervals of said rim, said spacer being attached to said shielding apparatus at discrete portions thereof, such that when said spacer contacts said rim, spaces between said discrete intervals are defined between the upper perimeter of said rim and the shielding apparatus, and said spaces allow fluid access to said second opening.
- 19.** A method as defined in claim 18, wherein:
 the shield apparatus has a top surface;
 the method further comprising providing airborne portions of said liquid to fill the reservoir; and
 the shield apparatus is configured such that the top surface of the shield apparatus is aligned with the second opening of the tube as the shield apparatus floats in said liquid in the reservoir such that the airborne portions of the liquid are deflected from the top surface of the shield apparatus into the reservoir.
- 20.** A method as defined in claim 18, wherein said shielding apparatus further comprises:
 at least one stem extending into the second opening of said tube.
- 21.** A method for shielding an entrance to a tube from a liquid, said method comprising:
 providing a reservoir for containing a liquid;
 providing a tube having first and second opposing openings in fluid communication with a lumen extending therebetween, wherein the first opening is in fluid communication with an exit from the reservoir;
 providing a shielding apparatus including:
 a deflection surface;
 a spacer such that when said spacer is in contact with said tube a space is provided between at least a portion of said shielding apparatus and an upper rim surrounding said second opening of said tube;

a material causing buoyancy of the shielding apparatus when immersed in said liquid, and
 a configuration such that, as the shielding apparatus floats in said liquid in the reservoir:
 the deflection surface of the shield apparatus is
 vertically aligned with the second opening of the
 tube as the shield apparatus; and
 the shielding apparatus freely moves relative to the
 tube;

positioning the shielding apparatus to rest upon the tube
 such that the deflection surface of the shield apparatus
 is vertically aligned with the second opening of the
 tube.

22. The method as defined in claim **21**, further comprising
 providing airborne portions of said liquid that enter and fill
 the reservoir while the deflection surface of the shield
 apparatus is aligned with the second opening of the tube as
 the shield apparatus floats in said liquid in the reservoir.

23. The method as defined in claim **22**, wherein:

the reservoir includes first and second adjacent compart-
 ments each for containing said liquid;

the first compartment is not in fluid communication with
 a second compartment;

the tube is in the second compartment; and

providing airborne portions of said liquid that enter and
 fill the reservoir includes causing said liquid in said first
 compartment to:

become airborne;

contact and be deflected by the deflection surface of the
 shielding member into said second compartment;
 and

fill the second compartment such that said shielding
 member floats in the liquid in the second compart-
 ment.

24. The method as defined in claim **23**, further comprising
 filling the second compartment with said airborne portions
 of said liquid until the liquid in the second compartment:

rises in the second compartment to enter the second
 opening of the tube;

flows through the lumen in the tube; and

exits the reservoir at the first opening of the tube.

25. An apparatus as defined in claim **1**, wherein:

the reservoir includes first and second adjacent compart-
 ments each for containing liquid;

the first compartment is not in fluid communication with
 a second compartment; and

the first opening to the tube is in the second compartment.

26. An apparatus as defined in claim **7**, wherein:

the reservoir includes first and second adjacent compart-
 ments each for containing liquid;

the first compartment is not in fluid communication with
 a second compartment; and

the first opening to the tube is in the second compartment.

27. An apparatus for preventing loss of liquid comprising:
 a reservoir for containing a liquid;

a tube having an opening and being in fluid communica-
 tion with an exit from the reservoir; and

a shielding apparatus that maintains vertical alignment
 with the opening of the tube while floating free relative
 to the tube in the liquid in the reservoir such that the
 shielding apparatus prevents airborne portions of the
 liquid from entry into the tube.

28. An apparatus as defined in claim **27**, wherein:

the reservoir includes first and second adjacent compart-
 ments each for containing said liquid;

the first compartment is not in fluid communication with
 a second compartment; and

the first opening to the tube is in the second compartment.

29. The apparatus as defined in claim **27**, wherein:

the opening to the tube is a second opening to the tube that
 is opposite a first opening of the tube;

the first opening to the tube is attached to and in fluid
 communication with the exit to the reservoir; and

the first and second openings are in fluid communication
 with a lumen extending therebetween.

30. A liquid loss prevention apparatus comprising:

a reservoir including a first compartment not in fluid
 communication with a second compartment each for
 containing a liquid, the first compartment including a
 gravity fluid outlet from the reservoir;

a tube, within the second compartment, having first and
 second openings at opposite ends thereof that are in
 fluid communication with a lumen extending
 therebetween, the first opening being attached to and in
 fluid communication with the gravity fluid outlet from
 the reservoir; and

a shielding apparatus having a spacer such that when said
 spacer is in contact with said tube a space is provided
 between at least a portion of said shielding apparatus
 and a rim surrounding said second opening of said tube,
 and such that, while making a floating movement in the
 liquid in the second compartment relative to the tube,
 the shielding apparatus:

maintains vertical alignment with the second opening
 of the tube;

floats free relative to the tube; and

prevents airborne portions of the liquid projected from
 the first compartment from entry into the second
 opening of the tube.

31. An apparatus for preventing loss of liquid comprising:

a reservoir including a first compartment and a second
 compartment each for containing a liquid, the second
 compartment including a gravity fluid outlet from the
 reservoir;

a tube, within the second compartment, having first and
 second openings at opposite ends thereof that are in
 fluid communication with a lumen extending
 therebetween, the first opening being attached to and in
 fluid communication with the gravity fluid outlet from
 the reservoir; and

a shielding apparatus that maintains vertical alignment
 with the second opening of the tube while floating free
 relative to the tube in the liquid in the second compart-
 ment such that the shielding apparatus prevents air-
 borne portions of the liquid from the first compartment
 from entry into the tube, said shielding apparatus
 having a spacer such that when said spacer is in contact
 with said tube a space is provided between at least a
 portion of said shielding apparatus and a rim surround-
 ing said second opening of said tube.

32. An apparatus for preventing loss of liquid comprising:

a reservoir including a first compartment and a second
 compartment each for containing a liquid, such that the
 liquid can cascade from the first compartment into the
 second compartment, the second compartment includ-
 ing a gravity fluid outlet from the reservoir;

a tube, within the second compartment, having first and
 second openings at opposite ends thereof that are in
 fluid communication with a lumen extending
 therebetween, the first opening being attached to and in

11

fluid communication with the gravity fluid outlet from the reservoir; and
a shielding apparatus that maintains vertical alignment with the second opening of the tube while floating free relative to the tube in the liquid in the second compart-

12

ment such that the shielding apparatus prevents airborne portions of the liquid from the first compartment from entry into the tube.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,286,554 B1
DATED : September 11, 2001
INVENTOR(S) : Dennis Staley

Page 1 of 2

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 2,

Line 33, after "liquid" delete "to"

Line 39, change "head" to -- heated --

Column 3,

Line 55, after "order" change "that" to -- to illustrate --

Column 4,

Line 7, before "depiction" change "an" to -- a --

Line 11, before "depiction" change "an" to -- a --

Line 23, before "depiction" change "an" to -- a --

Line 44, after "being" change "displaces." to -- displaced. --

Column 5,

Line 38, after "Space" insert -- 64 --

Line 67, after "drain" insert -- tube 34. --

Column 6,

Line 6, after "order" insert -- to --

Column 8,

Line 43, after "method" change "fisher" to -- further --

Column 9,

Line 2, change "liquid," to -- liquid; --

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,286,554 B1
DATED : September 11, 2001
INVENTOR(S) : Dennis Staley

Page 2 of 2

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 10,

Line 7, after "opening" change "o" to -- to --

Line 10, after "second" change "opposing" to -- openings --

Signed and Sealed this

Twenty-first Day of January, 2003

A handwritten signature in black ink, appearing to read "James E. Rogan", with a horizontal line drawn underneath it.

JAMES E. ROGAN
Director of the United States Patent and Trademark Office